Proposal for a Joint IAPSO/SCOR Working Group on Deep Ocean Exchanges with the Shelf

Background

As part of its strategy for improving its role in the 21st century, the International Association for the Physical Sciences of the Oceans (IAPSO) has established a new international programme on Deep Ocean Exchanges with the Shelf (DOES). The primary goal of DOES is to understand the physical and chemical interactions taking place at the shelf break between the deep ocean circulation and the shelf currents. The shelf break is a region of steep slopes, strong narrow currents, internal tides, shelf waves and significant vertical motion. There will be a DOES symposium at the Joint Assembly in Cairns in August 2005 (convened by Dr. J. Johnson and Dr J.Middleton).

With the advent of much finer resolution to ocean models, it is a good time to address the links between the shelf circulation and the deep ocean circulation at the shelf break. Improved understanding of the exchanges between the shelf and the deep ocean will be useful for more realistic models for studying climate, the carbon cycle, sedimentation and fish stocks. Improved models can also assist observational oceanographers in planning their next cruises.

A joint working group (WG) between the Scientific Committee on Oceanic Research (SCOR) and IAPSO is proposed as, although the principal work of the working group will be in physical oceanography, the output from the working group will have interdisciplinary interest for chemists and biologists. It also aims to involve scientists from developing countries. The support of SCOR will enable the members of the working group to meet on three occasions to push forward the research required on this topic.

Rationale - Deep Ocean Exchanges with the Shelf

Even as ocean models become more realistic by having much finer resolution in space and time, there are still significant problems in resolving the high variability that occurs around the shelf break between the deep ocean and the continental shelves. Modellers have often regarded the shelf break as the nominal seaward boundary of shelf models or the coastal boundary of deep ocean models. Even with the finest resolutions in ocean general circulation models, the shelf region is poorly resolved with only a few grid points. Ocean observers have difficulty in securing measurements at the edge of the shelf due to the narrowness of the currents and steep slopes.

The exchanges and fluxes that occur near the shelf break are important parts of the global ocean circulation. These fluxes include sediments and biomass as well as seawater. Coupled ocean atmosphere general circulation models require, for example, the input of freshwater outflow from rivers. This is generally added at the location of the river. But, in reality the fresh water flows along the shelf, sometimes for considerable distances, before it crosses the shelf break and enters the deep ocean. Similarly the formation of Antarctic Bottom Water and other dense water masses often occur over continental shelves before they flow offshore. An example of a biological flux is the movement of patches of krill on and off the Antarctic shelf.

Strong tidal mixing at the shelf break is an important feature in the energy balance of the Earth's oceans. Internal and surface tides are built into shelf models but are absent from deep ocean general circulation models. Strong mixing associated with significant topography is an important component in the theories of the thermohaline circulation. Coastal models often use terrain-following coordinate systems (sometimes called sigma coordinates). Although this method deals better with the changes in shelf slopes compared with models using standard grid boxes, they introduce significant problems due to pressure gradient force error.

Improved models and a better understanding of the processes that occur between the shelf and the deep ocean will be of benefit in maintaining fish stocks, to dealing with threats of pollution from oil and gas wells, and for studying river runoff and sedimentation. Coastal areas are often regions of enhanced primary production due to coastal upwelling. Understanding the carbon cycle in such ecosystems has consequences for climate studies.

Interaction with other programmes

Two SCOR WGs have links with this proposed WG. WG 111 on Coupling Waves, Currents, and Winds in Coastal Models is co-chaired by Christopher Mooers (who is one of the members of the proposed WG). Output from WG 111 will form part of the current knowledge of the shelf oceanography. The ongoing IAPSO/SCOR WG 121 on Ocean Mixing will provide useful input about deep ocean mixing to the proposed WG.

The carbon cycle in the shelf and upwelling zones is an important ingredient for the modelling by the Climate Variability and Predictability program (CLIVAR). The discussion of applications on chemical and biological fluxes needs to be in collaboration with projects such as the International Geosphere-Biosphere Programme (IGBP) Land-Ocean Interactions in the Coastal Zone (LOICZ) project and the SCOR/IGBP Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project.

Joint Working Group

IAPSO proposes formation of an international joint working group with SCOR to oversee the DOES programme. IAPSO wishes to foster research work on the links between shelf and deep-sea oceanography by using the DOES working group to generate ideas and encouragement for future research by the wider oceanographic community with funding from national and international bodies. The topics to be covered by the working group include:

(1) Physical processes due to shelf waves, internal tides, shelf break upwelling;
(2) River and estuary input of sediment and fresh water;
(3) The influence of ocean physics around the shelf break on fisheries and climate;
(4) Dissipation of tidal motion along the continental margins;
(5) Flows over sills;
(6) Chemical and biological flux exchanges between the deep ocean and coastal ecosystems; and

(7) Coupled physical-chemical-biological numerical models that have a better description of the exchanges at the shelf edge.

Topic (2) will concentrate on the use of data from LOICZ and others in the boundary conditions of numerical models of the shelf and deep oceans. For topics (6) and (7) the DOES WG will collaborate with IMBER and LOICZ to complement their work and avoid unnecessary duplication. Improved models of the flows over the shelf break will be useful to the IMBER modelling project.

Terms of reference

The working group will complete the following tasks, over a period of four years:

(1) Establish the current state of knowledge in the above topics and identify new research that should be encouraged;
(2) Determine where further observations are needed to help with the formulation of better models;
(3) Serve as an international forum for physical oceanographers to discuss current research on the interaction between the coastal zone and the deep ocean;
(4) Foster collaboration between developed and developing countries that have interest in the shelf zone: Limited area models are required to help scientists in countries that do not have access to large computers; and
(5) Set up a Web site that can be used by the DOES community for exchange and discussion of results and proposals for research and for dissemination to the wider community.

The working group will complete its work with a final report to SCOR and IAPSO and with the organisation of an international DOES symposium at the summer 2009 IAPSO Joint Assembly.

Timetable

Support is requested for three working group meetings (up to 10 persons per meeting):

1. February 2006 at the Ocean Sciences Meeting in Hawaii,
2. July 2007 in Perugia in association with the IUGG General Assembly;
3. Summer 2009 in association with the IAPSO Joint Assembly, location to be determined, for final discussion and input to the working group's report.

The first meeting of the WG will concentrate on summarising the present state of knowledge, and then topics will be assigned to members of the WG (and any coopted associate members) for them to encourage new research proposals for the IAPSO community and to report and discuss at the second meeting.

Membership

Working group membership is proposed to consist of up to ten specialists from various countries with expertise in both modelling and observations of the oceans. Associate members may be coopted to help with biogeochemical applications. The following group is proposed:

John Johnson (chair, UK)	Ocean models, particularly shelf and shelf break. Limited area models.
Isabel Ambar (Portugal)	Ocean observations, particularly off Iberia. Meddies.
Jack Barth (USA)	Frontal instability processes. Coastal ocean dynamics (observations and models).
Hu Dunxin (China)	Physical oceanography and marine sedimentation. West Pacific boundary.
Christopher Mooers (USA)	Coastal ocean circulation dynamics. Shelf break processes. Regional circulation models.
John Middleton (Australia)	Ocean circulation over continental shelves. Coastal trapped waves.
Frank Shillington (South Africa)	Remote sensing of sea surface temperature and ocean colour.
Olga Trusenkova (Russia)	Bathymetric effects in the Japan Sea.0
Takeshi Matsuno (Japan)	Water exchanges between the East China Sea and the Kuroshio. Biological production over the shelf.
Eric Wolanski (Australia)	Marine biology. Coral reefs.

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